

COSMONAUT'S EMOTIONAL STRESS IN SPACE FLIGHT

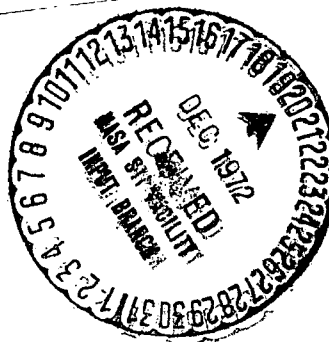
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Man's participation in space flights has been a unique type of activity, and those who have devoted themselves to it are fully aware of its magnitude and complexity. The cosmonaut's emotional experience that is well reflected by data on pulse and respiration frequency, biological currents of the brain, speech pattern, and spectral characteristics of voice is extremely diverse, and its subjective manifestations are much more complex and vivid than in people under ordinary conditions of terrestrial gravitation. The data available indicate that realization of the historical significance of scheduled operations has a certain way of depressing and organizing the cosmonaut's emotional response under most complex situations even in highly trained individuals having utmost confidence in the technology under which they are to execute the flight. The striking precision of movements by A. A. Leonov on his first walk into outer space and of those by P. I. Belyayev on his first manual landing of Voskhod-2, the transfer of A. S. Yeliseyev and Ye. O. Khrunov from one space ship to another during the space flight sheds a new light on the cosmonaut's emotional experience. In most cases the symptoms of strong emotional upheaval are most likely associated with the realization of the historical significance of their activity rather than with the subconscious realization of the risks involved. During landing Lunokhod on the moon and guiding its initial walk over the lunar surface the pulse frequency in ground-based crew members was at times as high as 130-135, while their respiratory delays lasted several seconds. Emotional stress is undoubtedly caused by a variety of space flight factors including accelerations, weightlessness, etc. These coupled with emotional stresses reduce the cosmonaut's ability to withstand physical stresses. The cosmonaut's emotional state in flight is evaluated on the basis of various indices that include behavioral and professional responses, dynamics of vegetative shifts (pulse and respiratory frequency, arterial pressure) as well as voice characteristics of the cosmonaut's speech. Of the vegetative indices, cardiac contractions are regarded as the most reliable and objective index unaffected by various interferences of technical nature occurring during the reception of physiological information from space. In recent years increasing emphasis has been placed on the acoustic indices of speech material. This new approach offers certain advantages since it uses regular communication channels without additional on-board equipment. The emotional stress is frequently determined by the degree of professional responsibility. By way of example, the authors relate the dynamics of the emotional response in the crew member of Voskhod-2 during the most critical stages of the flight: the extravehicular activity

of co-pilot Leonov in space and the manual landing of the spacecraft by Belyayev. Comparison of the pulse frequency during preparation and training for these stages with that in real flight reflects the most strenuous moments of these flight stages (Fig. 1). Seven minutes prior to opening the airlock chamber hatch and facing open space, Leonov's pulse frequency fluctuated within 87-90 and was about the same as that observed during training in the pressure chamber. Then, however, the instant the hatch was opened, Leonov's pulse frequency jumped by 60 beats (within 6 minutes) to as high as 147-162. One minute after the cosmonaut returned to the airlock chambers, his pulse frequency dropped to 138, after 2 minutes -- to 117, and after 4 minutes -- to 90. Within 4 minutes after Leonov returned from his world's first expedition in space, his pulse frequency came down to its normal level. A somewhat different picture, on the same flight, was reflected by the command pilot P. I. Belyayev. His maximum pulse frequency was observed 7-10 min prior to opening the hatch. After Leonov had left the space ship, despite the fact that Belyayev continued monitoring Leonov's space walk, his pulse frequency began to drop and after 5 min came down to the pre-flight training level in a pressure chamber. The dependence of the cosmonaut's emotional stress on the degree of professional responsibility is well demonstrated by another example on the same flight. Analysis of physiological information at the landing stage reflecting the dynamics and pattern of emotional stress in crew members shows an abrupt increase in Belyayev's pulse frequency the instant he was given permission to switch to manual control. After appropriate maneuvering of the space ship and in-ready to cut in the retropack, Belyayev's maximum pulse frequency was registered at 129. After cutting in the retropack, his pulse frequency came abruptly down, even though the crew was actively engaged at the controls; the pulse remained at its lower level even during passage through the terrestrial atmosphere. It is interesting that the overall background of activity of the crew depends largely on the feeling of "belonging to the team" (Fig. 2). The authors discuss in some detail the spectral changes of the cosmonaut's voice with the degree of emotional stress -- the spectral moment increases toward higher frequencies.

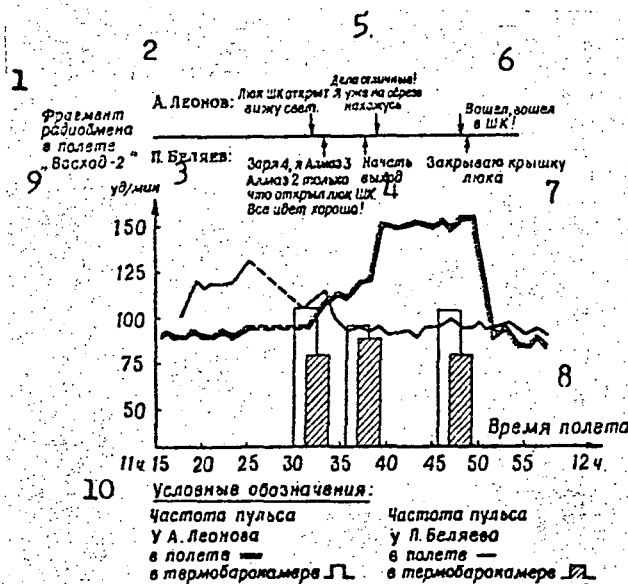




Fig. 1. Emotional Stress of Voskhod-2 Crew Members During Leonov's Walk Into Outer Space.

- 1 -- Excerpt from the Radio Conversation Between Leonov and Belyayev:
- 2 -- L.: "The Airlock Hatch is Open, I See Light"
- 3 -- B.: "Zarya-4, This is Almaz-3, Almaz-2 has just opened the Hatch, Everything is Fine"
- 5 -- L.: "Everything is OK, I'm at the Edge"
- 4 -- B.: "Start Exit"
- 6 -- L.: "I'm in the Airlock"
- 7 -- B.: "Am Closing the Hatch"
- End of Conversation
- 8 -- Flight Time, hr
- 9 -- Beats per minute
- 10 -- ARBITRARY DESIGNATIONS:
 Leonov's Pulse Frequency in Flight ==
 Leonov's Pulse Frequency in Pressure Chamber 
 Belyayev's Pulse Frequency in Flight ==
 Belyayev's Pulse Frequency in Pressure Chamber 

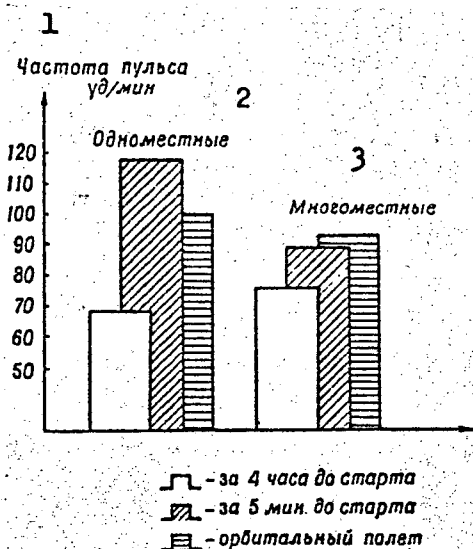


Fig. 2. Cosmonaut's Emotional Stress in Flight (Based on Cardiac Contraction Frequency) on Single- and Multiseat Spacecraft

1 -- Pulse frequency, per min	-- 4 hr before start
2 -- Single-seat spacecraft	-- 5 min before start
3 -- Multiseat spacecraft	-- Orbital Flight

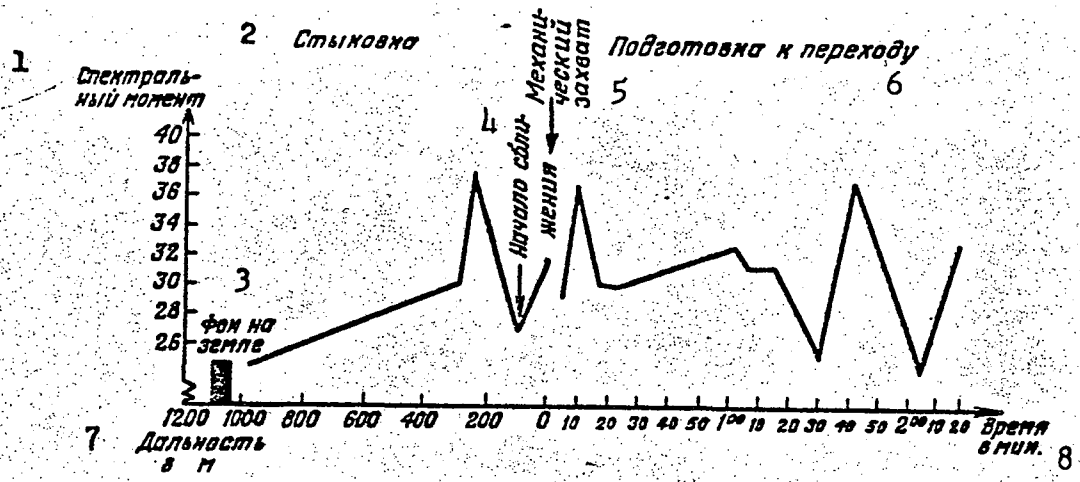


Fig. 3. Emotional Stress of the Active Spacecraft Commander During Docking and Prior to Transfer of Crew (Based on Spectral Speech Characteristics)

- 1 -- Spectral Moment
- 2 -- Docking
- 3 -- Background on Earth
- 4 -- Beginning of Approach
- 5 -- Mechanical Locking
- 6 -- Preparation to Transfer
- 7 -- Range in meters
- 8 -- Time, in min.

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